Land Use Policy 79 (2018) 301–309

Contents lists available at ScienceDirect

Land Use Policy

journal homepage: www.elsevier.com/locate/landusepol

Farmers' risk perception, vulnerability, and adaptation to climate change in rural Pakistan

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ARTICLE INFO

Keywords:
Climatic risks
Climate variability
Floods and droughts risks
Adaptation
Vulnerability
Pakistan

ABSTRACT

Pakistan is the world's most susceptible country to extreme climatic events, such as floods and droughts. This study aims to investigate the risks related to climate variability and the adaptation measures utilized by farm households in their farms to cope with the adverse shocks of climatic disasters. A dataset of 600 respondents was collected using structured questionnaire from four districts namely Charsadda, Mardan, Nowshera and Peshawar of Khyber Pakhtunkhwa province of Pakistan. Findings of the research showed that soil fertility loss, water scarcity, changes in crop yields and crop diseases were the main determinants of climate variability. Further study participants were also utilizing several adaptation techniques such as change in crop type and variety, change fertilizer, seed quality, pesticide, plant shade trees; water storage and farm diversification. Results of our study further showed that in the study area, study participants were facing various constraints in adoption of certain adaptation measures to deal with climate variability, such as shortage of labor, insecure land tenure system, lack of market access, poverty, land of governmental support, lack of access to assets, lack of water sources, lack of credit sources and lack of knowledge and information were the main constraints faced by the farm households. Findings of this research provide useful insights to the responsible authorities for policy implementation. Our study further suggests that the government should provide proper support to the farmers in the shape of access to farm inputs, access to information and extension services on climate variability and adaptation.

1. Introduction

Climatic change effects all regions across the globe, which causes substantial agitations that can be expected to be natural systems that have foreseeable influences on the economic systems of upland regions (Kohler and Maseli, 2009) through both direct and indirect means (Fahad et al., 2018a). Poor and agricultural communities of the developing world are affected most by the climate change, because they have poor adaptive capacity and inadequate access to alternate means of production (Kurukulasuriya and Rosenthal, 2003; IPCC, 2007; Skoufias et al., 2011). Several studies have projected that variations in climatic conditions is more likely to rise the incidence and magnitude of some risky climatic events and disasters including, droughts, floods, cyclones and storms (Field, 2012). This is might be geographical positions and locations the most vulnerable areas of the world, limited assets, high exposure, and rapid population growth (Hay and Mamura, 2010).

Developing countries, especially south Asian countries including Pakistan are the most affected regions that are related to the risks of climate change, in the form of increase in temperature and fluctuation in precipitation; however, the worst is yet to be expected (Ali and Erenstein, 2016; IPCC, 2014; Mirza, 2003). Among different natural hazards to which humans are exposed and give rise to fatalities, floods are the most common and leading cause of economic and social risks for people. In particular rural populations in developing countries are always vulnerable to flood events owing to low adaptive capacity and resources (Fahad and Jing, 2018). The intensity and severity of flooding incidents in developing countries are mainly associated with environmental and climatic changes. If the effects of climate change on agricultural systems are not identified efficiently, it could extremely affect the production of food, food security and also could be an obstacle in poverty reduction efforts and sustainable development. Low-income countries, that are located at lower latitudes are more vulnerable to climate change and increase in temperature in the near future may push these low-income regions further away from optimal temperatures for climate sensitive economic sectors (Mendelsohn and Dinar, 2009), that may affect more than 170 million people to the risk of hunger around the globe by 2080 (Schmidhuber and Tubiello, 2007). Climate change

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https://doi.org/10.1016/j.landusepol.2018.08.018
Received 26 April 2018; Received in revised form 11 August 2018; Accepted 12 August 2018
Available online 25 August 2018
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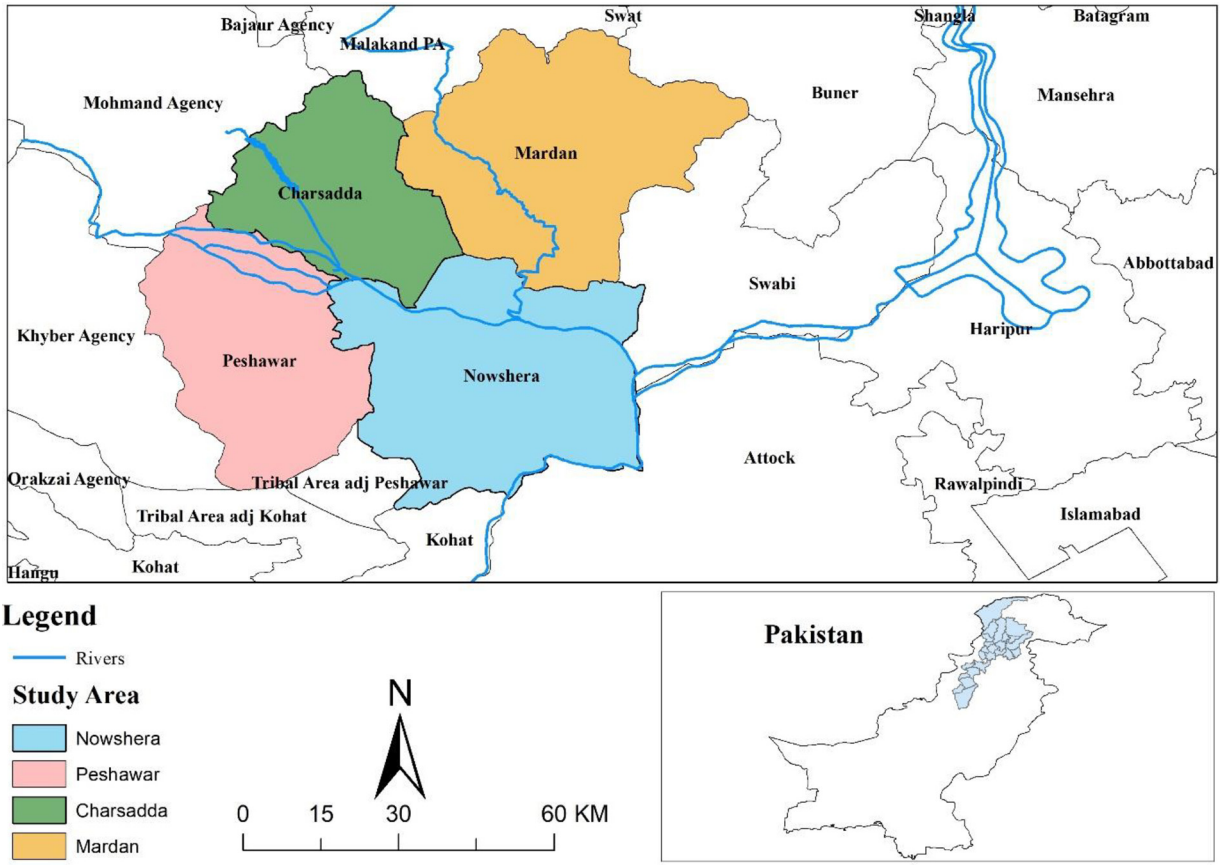

Fig. 1. Map of the study area.

will significantly affect the productivity of crops and lead to important changes in farming outcomes (IPCC, 2014). Moreover, extreme weather-related events, soil salinity in coastal areas and incidence of pests and diseases may result in additional negative effects on agriculture sector (IPCC, 2014). Despite the technological advancement, climate is still a fundamental determinant of agricultural productivity where temperature and rainfall act as main drivers in crop production and by consequence rural food security (Huong et al., 2018a; Wheeler and von Braun, 2013).

Pakistan's vulnerability to the impacts of climate change has been increasing with time despite its contribution to global warming being negligible. Pakistan was ranked 12th, 8th position in 2012, 2015, and ranked 7th among uppermost regions of the world exposed to the whims of climate change (Kreft and Eckstein, 2013). Recent floods and other climatic disasters such as droughts, storms and cyclones have hit Pakistan badly (Mueller et al., 2014; Tingju et al., 2014). These climatic disasters not only become more recurrent but also triggered more damage (Qasim et al., 2015). Even after having been consistently affected by climate exigencies year after year, the country's response to solve the issue has remained lackluster. The natural disasters in Pakistan such as 2010–2014 floods have badly devastated millions rural households. Besides this, according to (Cardona et al., 2003; Huong et al., 2018b) the growth in population, unmanaged infrastructure are also the common influencing factors that resulting in people more vulnerable to uncertain climatic risks. Several studies have reported that rural people of Pakistan are highly vulnerable to climate change (Deressa et al., 2009; Füssel and Klein, 2006), and these rural population are badly affected by climatic changes recognized by many research studies throughout the country (Qasim et al., 2015; Tingju et al., 2014). A consistent big problem for Pakistan's establishments is that climatic hazards arise regularly, but adequate use of recent developments in policies, strategies and cost-effective tools and sustainable interventions are still missing in Pakistan (Qasim et al., 2015). In South Asia, wheat and rice are the two main food crops for 1.5 billion people, these both crops are subtle to heat-stress, though rice is not sensitive than wheat (Lobell and Gourdji, 2012). Lower rice and wheat yields are expected not only in South Asia but across the globe due to climate change (Asseng et al., 2011; Lobell and Gourdji, 2012; Naylor et al., 2007).

Various literature have identified that there is an urgent need of risk perceptions, climate change vulnerability and adaptation at household level in order to reduce the adverse effects of climate change on farming sector (Abid et al., 2016). Previous studies have shown that farmers always use several techniques for adaptation of agriculture to climate change vulnerability (Ali and Erenstein, 2016). The farmers use several techniques at their farm level such as changing in timing of operations, diversification in crop practices (Deressa et al., 2009, 2011); changing farm-management such as amount and type of farm inputs applied (Abid et al., 2016; Fahad et al., 2018a) institutional changes, mainly government responses, such as subsidies and improvement in farm marketplaces (Mendelsohn et al., 2001); livelihood diversification (Hussain and Mudasser, 2007) and technological advancements such as cultivation of new and heat tolerant crops and advancement in irrigation and water management methods (Deressa et al., 2009, 2011; Hussain and Mudasser, 2007).

Surprisingly, studies concerning the climate change vulnerability are with extreme climatic events are very limited, in Khyber Pakhtunkhwa (KP) province of Pakistan, which is one of the most vulnerable provinces of Pakistan. To fill the literature gap discussed above, this study is expected to provide valuable evidence regarding the climate change vulnerability based on farmers direct responses to various types of agriculture risks. This study further identifies the major factors associated with climate change vulnerability, adaption techniques using by farm households, and risk perception of farmers towards adverse effects of climate change.

2. Materials and methods

2.1. Study area

The data were collected from four districts namely Charsadda, Mardan, Peshawar, and Nowshera of Khyber-Pakhtunkhwa (KP) province, Pakistan as illustrated in Fig. 1. KP province is located in the northwestern region of the country and is bounded by Afghanistan to the west and north. The economy of KP province is fundamentally farming, although the rugged landscape is unfavorable to extensive farming. Khyber Pakhtunkhwa province was purposively selected because of its previous history identified as vulnerable to climate change (Fahad and Jing, 2018; Ullah et al., 2015a,b), and agriculture contributes approximately 38 per cent to the provincial gross domestic product and provides employment for 44 per cent of the total population (Khan, 2012; Fahad et al., 2018b). These four districts were purposely selected owing to their vulnerability, flooding history, agricultural importance, and severity of flood damage. Further three tehsils from each district were chosen following by random selection of villages that are located at river banks. The selected study site faces extreme climatic events such as floods and droughts. In recent history of KP province floods have severely affected the farming sectors that caused huge harm to humans, land and property loss.

2.2. Data collection

A semi-structured questionnaire was used to collect data of the households. In order to collect data regarding farmers' responses to different climate conditions and their experiences with climatic events, a bottom up technique was utilized. Prior to start data collection process in the selected four districts, a meeting with society educated members especially school teachers, elder people of the village with proper knowledge, and farmers with enough experience was conducted for identification of vulnerable areas. Data were collected by four trained Ph.D. and master students; the sampling framework is illustrated in Table 1. Prior to participation in the survey, the participants were duly informed and assured about that the survey is purely for academic purposes, and that it was not compulsory for them to respond to the questionnaires (McCusker and Gunaydin, 2015). In these four districts of Khyber Pakhtunkhwa province of Pakistan, the Pakhtun ethnicity reside, where women are not allowed to work with male (Qasim et al., 2015). So that, data were only collected from male households because it was not possible to collect data from women households to investigate their perceptions. For this survey total 600 households were randomly selected.

During the field survey, In order to avoid discrepancies, a pre-test was carried out before the actual survey and the study participants who were not willing to participate in the survey were substituted with other study participants. The questionnaire included questions regarding households' socio-economic characteristics such as gender, age, education, farming experience, primary occupation, assets such as mechanical assets, electrical, transportation, knowledge on climate change and its impacts on agriculture, farm equipment, vulnerability perceptions, adaptation techniques used to lessen adverse effects of climate change, and the constraints to adaptation. Perceptions of households on climatic risks, perceptions on weather related changes such as excess precipitation, change in temperature and droughts. Further, perception on agricultural production such as crop diseases, severe weather condition, and lack of access to farm inputs.

Table 1
Surveyed areas.
Source: Field Survey.

District	Tehsils	No of interviewed farmers
Peshawar	Peshawar	150
Mardan	Takht e Bhai	50
	Katlang	50
	Mardan	50
Charsadda	Shabqadar	50
	Charsadda	50
	Tangi	50
Nowshera	Pabbi	50
	Jahangira	50
	Nowshera	50
Total		**600**

3. Results and discussion

3.1. Demographic and farm characteristics of study participants

Demographic and farm characteristics of households are presented in Table 2. In all districts, most of the respondents were in the age of 31–50 years. In district Charsadda, 34 per cent of the households had more than 5 years education, in district Mardan it was 54% and in district Nowshera and district Peshawar this proportion was 77 and 45%. The family size was large in all district, i.e. 8–9 persons per household, that were also providing labor force in farming. The majority of farmers were experienced. Slightly more than half of the respondents in districts Charsadda and Mardan had 20–35 years of farming experience, but in districts Nowshera and Peshawar the ratio was high as distributed with almost 80 and 63%, among the all categories (Table 2). In these four districts, majority of the farmers use both tractors and bullocks for plowing land. The ratios in district Charsadda, Mardan, Nowshera and Peshawar were 85%, 56, 58 and 100% respectively. More than 60% households in four districts plowed their land a minimum of twice per year. Households of district Charsadda irrigated their farms with canal water, but in district Mardan, Nowshera and Peshawar more than majority of farmers used tube-wells for irrigation. Majority of the respondents of the district Charsadda, Mardan and Nowshera irrigated their farm lands twice a month, while in district Peshawar majority of farmers irrigated their farms on weekly basis. More than 60% farmers in district Charsadda, Mardan and Nowshera heard about climate change through village elders, while in district Peshawar farmers was aware of climate change though friends and relatives. The previous studies have extensively covered the importance of socioeconomic as well as demographic characteristics of farmers' regarding climate change vulnerability and adaptation techniques farmers are using at their farms (Abid et al., 2016; Bryan et al., 2009). The findings of our study can be used by policy makers to provide best support to the poor and vulnerable farmers, and to make their lives more sustainable with improvement in their farming practices. For adaptation and implementation of best measures at farm level, the government involvement and leadership in planning is very essential (Bryan et al., 2009, 2013).

3.2. Assets for livelihood

Study participants of the four districts were inquired about their assets for supporting their livelihood. Table 3 presents the assets owned by the farmers such as electrical, mechanical, transportation, and agricultural equipment. In these four districts of Khyber Pakhtunkhwa province of Pakistan, majority of the study participants owned cellphones, televisions, agricultural equipment such as water pump and spraying device. Limited number of farmers owned a tractor in the study area. Majority of the study participants were found having very poor economic condition and exposed to the whims of climate change. According to previous literature (Deressa et al., 2008, 2009; Ullah et al., 2015a,b). Agricultural assets and improved technology access stimulates growth in agriculture sector and poverty reduction. In order to analyze vulnerability, besides the threats identification recovery from the negative impacts of changing climatic conditions and resilience also needs to take into account that includes socioeconomic status of the

Table 2
Socioeconomic and farm topographies of study participants.
Source: Field Survey.

Characteristics	Categories	Districts (Study Area)			
		Charsadda %	Mardan %	Nowshera %	Peshawar %
Age (Years)	< 31	21	17	20	24
	31-50	68	48	47	56
	> 50	11	35	33	20
Education (Years)	0	63	31	23	29
	1-5	3	15	0	26
	> 5	34	54	77	45
Family Size	< 4	0	1	0	1
	4-7	15	15	5	13
	> 7	8	17	7	8
Farming Experience (Years)	< 20	23	33	12	22
	20-35	53	52	80	63
	> 35	24	15	8	15
Land Preparation	Use tractor	16	44	42	0
	Use both tractors and bullocks	84	56	58	100
Plowing per year	One	29	0	0	20
	Twice	42	100	47	70
	Three and more	29	0	53	10
Irrigation	Canal	97	0	0	0
	Tube-well	1	75	100	95
	Rain fed	1	9	0	0
	Both tube – well and rain fed	1	16	0	5
Frequency of Irrigation	Nil	1	0	0	19
	Weekly	11	9	5	59
	Twice a month	48	73	95	0
	Three times a month	32	15	0	10
	Monthly	8	3	0	12
Information Sources	Media	23	17	22	0
	Village elders	52	67	61	0
	Own view	12	10	17	33
	Friends and relatives	7	6	0	66
	Do not know	6	0	0	1

Table 3
Livelihood Assets in study area.
Source: Field Survey.

Assets		Districts (Study Area)			
		Charsadda %	Mardan %	Nowshera %	Peshawar %
Motorbike	No	74	16	66	67
	Yes	26	84	34	33
Bicycle	No	29	67	96	11
	Yes	71	33	4	89
Electric Generator	No	43	60	33	63
	Yes	57	40	67	37
Cellphone	No	24	53	15	48
	Yes	76	47	85	52
Radio	No	94	89	94	97
	Yes	6	11	6	3
Camera	No	54	63	44	65
	Yes	46	37	56	34.3
Washing Machine	No	96	91	95	94
	Yes	4	9	5	6
Tractor	No	91	94	93	88
	Yes	9	6	7	12
Plow	No	10	14	20	29
	Yes	90	86	80	71
Spraying Device	No	83	69	85	95
	Yes	17	31	15	5
Water Pump	No	20	22	35	28
	Yes	80	78	65	72
Wooden Cart	No	91	84	93	58
	Yes	9	16	7	42
Flourmill	No	83	69	85	95
	Yes	17	31	15	5
Scale	No	18	42	32	27
	Yes	82	58	68	73
Others	No	12	42	19	25
	Yes	88	58	81	75

farmers, access to credit and extension services, distance of farm from market, and household characteristics.

As farm households who were willing for risk reduction linked with the uncertain climate change and had access to different resources, had larger capacity to adapt (Deressa et al., 2011). In other words, farmers with larger capital consider themselves safe and can bear adverse effects of change in climatic condition. Qasim et al., (2015) explained that in developing country like Pakistan, small subsistence farmers are always at risk of natural climatic disasters like heavy precipitation, droughts, floods etc.

3.3. Determinants of climate change

Table 4 comprises the perception of the study participants about climate change in the study area. The responses of study participants in the four districts of Khyber Pakhtunkhwa province are also shown in Fig. 2 depending on their climatic risks perception. The indicators drinking water, soil problems, irrigation, transportation system and animal diseases were less threatning factors in these districts of Khyber Pakhtunkhwa province as illustrated in Fig. 2 and Table 4. In all these districts of Khyber Pakhtunkhwa province (study area), flood was considered as a major threatening indicator associated with climate change. In the Charsadda district 74% study participants perceived flood as moderate threatening indicator, while in Mardan 80%, Nowhsera 57% and Peshawar 45% of respondents perceived flood as a high threatening indicator. Flood is a major threat in all these district of Khyber Pakhtunkhwa, due to flood history in past recent years i.e. 2010–2014 that resulted huge loss to the economy, and their proximity to the Kabul River.

Several studies have reported that people living in rural areas associated with farming sector are severely affected by impacts of changes in climate (Ali and Erenstein, 2016; Field, 2012; Greenough et al.,

Table 4
Determinants of Climate Change.
Source: Field Survey.

Causes		Districts (Study Area)			
		Charsadda %	Mardan %	Nowshera %	Peshawar %
Droughts	High	21	5	12	15
	Moderate	68	81	71	46
	Low	11	14	17	39
Flood	High	18	80	57	45
	Moderate	74	13	28	37
	Low	8	7	15	18
Land Slide	High	28	21	50	57
	Moderate	68	72	36	23
	Low	4	7	14	20
Soil Problems	High	18	20	0	7
	Moderate	24	36	74	7
	Low	58	44	26	86
Drinking Water	High	26	20	6	7
	Moderate	20	50	68	19
	Low	54	30	26	74
Agriculture	High	41	73	46	32
	Moderate	51	13	39	37
	Low	8	14	15	31
Communication	High	47	16	26	29
	Moderate	42	81	71	32
	Low	11	3	3	39
Transportation System	High	21	5	19	15
	Moderate	40	65	55	35
	Low	39	30	26	50
Crop Pests	High	34	5	12	29
	Moderate	55	81	85	12
	Low	11	14	3	59
Animal Diseases	High	21	5	42	15
	Moderate	61	79	42	22
	Low	18	16	16	63
Forest	High	21	15	12	20
	Moderate	58	76	70	21
	Low	21	9	18	59
Irrigation	High	21	23	24	43
	Moderate	47	61	42	22
	Low	32	16	34	35

2001; Mirza, 2003). Abid et al. (2015) conducted as study in Panjab province of Pakistan and found similar results where longer summers, decrease in precipitation and changes in agricultural growing season were recorded by the farming communities. The frequency and magnitude of natural disasters like extreme temperatures, floods and droughts have been expected and seen in recent years (Maheen and Hoban, 2017).

Several researchers have revealed that only environmental factors are not responsible for the causes of vulnerability and disasters but also the ignorance of the people and destitution of the country (Adger and Kelly, 1999; Mustafa, 1998; Smit and Pilifosova, 2003; Wisner et al., 2012). Like other developing countries, a large population of Pakistan is poor and living in rural disastrous areas. As Pakistan has faced major floods of in 2010, 2011, and 2014 that caused massive damage to forestry, fisheries, livestock, infrastructure, tube wells, animal sheds, people, seed stocks, fertilizers, houses, and agricultural equipment. Furthermore, almost 250,000 farm households and approximately 1 million acres of cultivated land were devastated (NDMA, 2014). Pakistan has faced different scales of floods throughout the country, of which 20 were extremely severe. Despite the significant share in the overall economy, the agricultural sector has experienced serious challenges from catastrophic flood impacts (Hoanh et al., 2006).

3.4. Adaptation measures in study area

The study participants in these four districts were used to practice the main adaptation techniques, that includes change in crop type and variety, change fertilizer, seed quality, pesticide, plant shade trees; water storage and farm diversification as presented in Table 5 and Fig. 3. Changes in crop types and verities were mainly based on the nature of problems faced by the farmers, for example, attack of pests on the plants that may affect production. Change fertilizer, seed quality and pesticide were mentioned as adaptation techniques used by the study participants in the study area, which means that in the rainy season, the crops are exposed to pest attacks, they use different pesticides in order to cope with the pest/disease risks. While in the dry season, farmers were used to change the frequency of irrigation for their desired production. Likely, farmers were used to change fertilizer for enhancement in their production. In the study area, more than half study participants explained that in recent years the production of the crops have been decreased which may be due to climate change, poverty and lack of proper access to extension services or governmental agencies.

Farmers in these selected studies districts of Khyber Pakhtunkhwa province of Pakistan also adopted advance techniques for their protection from diverse shocks of natural disasters. Majority of the study respondents in the study area were also used to store the non-used water for other season, when they may face scarcity of water for the purpose of irrigation and they showed more concern because they already face water scarcity for irrigation. According to our survey, all the study participants were connected to the farming sector for their livelihood. Majority of the farmers of Pakistan are small farmers with less landholdings, and their primary occupation is agriculture. Small subsistence farmers are mainly exposed to the climatic risks such as floods and droughts. It has also been reported that some of the participants had adopted typical adaption techniques, it may be due to lack of

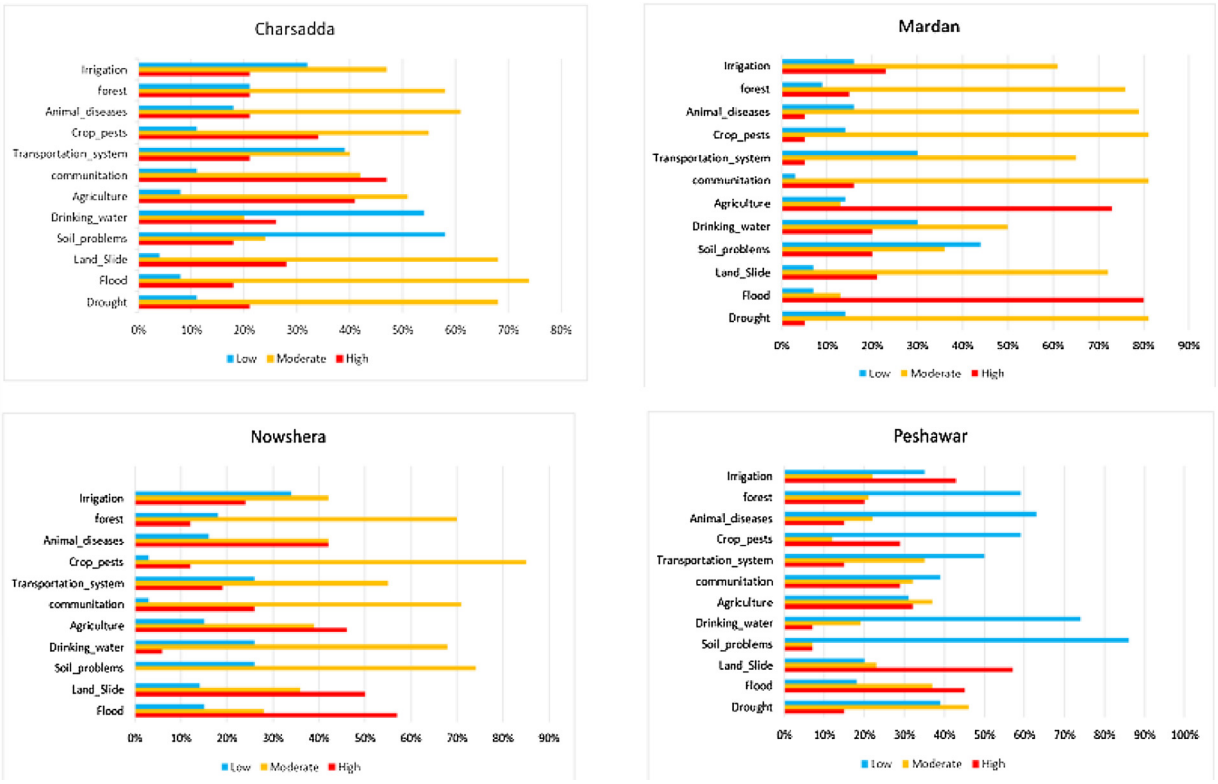

Fig. 2. Determinants of Climate Change in study area (four districts).

Table 5
Adaptation measures in study area.
Source: Field Survey.

		Districts (Study Area)			
Adaptation		Charsadda %	Mardan %	Nowshera %	Peshawar %
Change Crop Type	No	24	10	10	32
	Yes	76	90	90	68
Change Crop Variety	No	5	13	6	24
	Yes	95	87	94	76
Change Fertilizer	No	39	7	7	19
	Yes	61	93	93	81
Change Pesticide	No	9	17	20	11
	Yes	91	83	80	89
Change Irrigation	No	63	53	48	35
	Yes	37	47	52	65
Change Seed Quality	No	73	69	68	27
	Yes	27	31	32	72
Stop Cutting Trees	No	47	47	52	39
	Yes	53	53	48	61
Plant Shaded Trees	No	73	69	74	79
	Yes	27	31	26	21
Store Water	No	37	39	38	40
	Yes	63	61	62	60
Farm Diversification	No	71	67	79	38
	Yes	29	33	21	62
Praying	No	68	75	85	81
	Yes	32	25	15	19
Terracing	No	75	65	60	80
	Yes	25	35	40	20

education, awareness and knowledge about the advanced adaptation techniques (Ahmad et al., 2013).

This situation particularly applies to Pakistan where knowledge about the current process of adaptation and vulnerability aspects at farm level is still very limited due to lack of research on environmental vulnerability and local-level risk perceptions (Hussain and Mudasser, 2007). Adger and Kelly (1999) reported that timely adaption may reduce the negative impacts of climate change compared with those who adapt late.

3.5. Perceived Constraints to climate change adaptation at farm level

Table 6 and Fig. 4 showing the constraints perceived by the study participants during survey in four disaster prone districts of Khyber

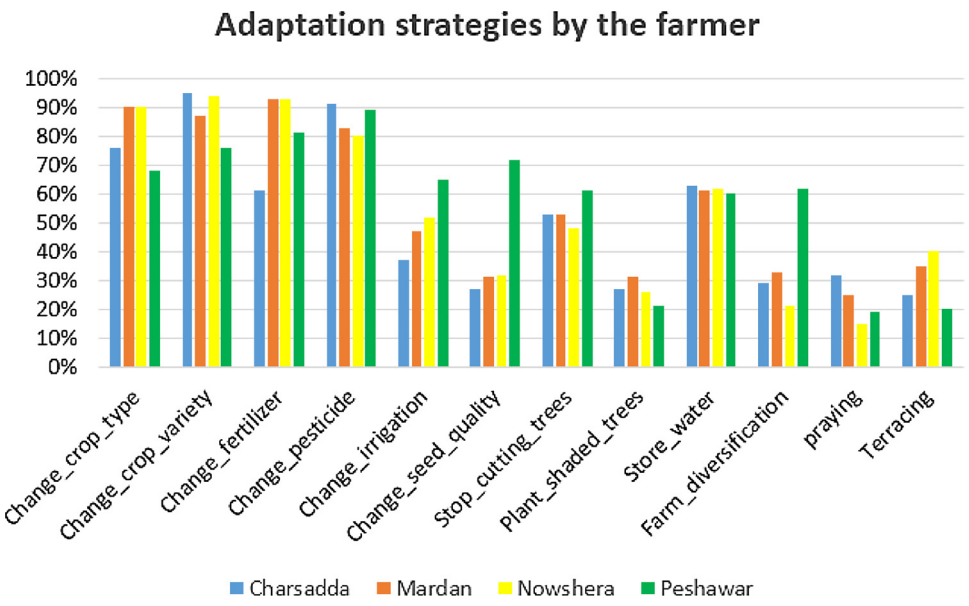

Fig. 3. Adaptation Measures in Study Area.

Table 6
Constraints to climate change adaptation in study area.
Source: Field Survey.

Constraints		Districts			
		Charsadda %	Mardan %	Nowhsera %	Peshawar %
Lack of Knowledge and Information	No	85	66	50	32
	Yes	15	34	50	68
Lack of Credit Money	No	45	64	40	22
	Yes	55	36	60	78
Lack of Water	No	56	87	76	53
	Yes	44	13	24	47
Lack of Access to Assets	No	91	43	54	40
	Yes	9	57	46	60
Lack of Governmental Support	No	50	71	69	63
	Yes	50	29	31	37
Poverty	No	30	40	42	35
	Yes	70	60	58	65
Lack of Market access	No	90	83	80	93
	Yes	10	17	20	7
Insecure Land Tenure System	No	95	93	89	85
	Yes	5	7	11	15
Shortage of labor	No	87	80	93	91
	Yes	13	20	7	9

Pakhtunkhwa Pakistan. The constraints to climate change adaptation reported by study participants that includes shortage of labor, insecure land tenure system, lack of market access, poverty, land of governmental support, lack of access to assets, lack of water sources, lack of credit options and lack of knowledge and information. In Charsadda district majority of study participants reported that poverty, lack of governmental support and lack of credit option were the major constraints to climate change adaptation. In Peshawar district of Khyber Pakhtunkhwa province, most of the study participants showed that lack of credit option, lack of knowledge and information about market prices and poverty were the main climate change adaptation constraints. Whereas in Mardan and Nowshera farmers reported poverty, lack of access to assets and lack credit the major constraints.

Previous studies (Huong et al., 2017; Piya et al., 2012) reported that access to climate related information and the factors specific to agriculture such as household extension services, soil quality and land tenure also can affect the perception of climate change. Access to credit, information sources and extension services access can positively influenced adaptation decisions of farmers (Kelly and Adger, 2000; Roncoli et al., 2002). The capacity of a household to cope with climate risks depends to some degree on the enabling environment of the community and is reflective of the resources and processes of the region (Smit and Pilifosova, 2003). However, to understand the importance of factors shaping farmers' decisions and responses to adapt, it is necessary to explore their acuities about constraints they dealt with (Bryan et al., 2009, 2012).

3.6. Perceived risks – climate change

Initially the risk associated with climate change were categorized in two categories i.e. perception of farmers on weather related risks and perception of farmers on production risks as illustrated in Tables 7 and 8. Regarding weather related risks, 87%% study participants of Peshawar district perceived drought as major risk source, while% age of study participants of districts Charsadda, Mardan and Nowshera drought was 73%, 57% and 59% respectively. In districts Charsadda, Mardan and Peshawar the farmers perceived change in temperature as second major risk source as showed in Fig. 5.

Farmers were further inquired their primary production risks, that includes lack of access to inputs, crop diseases and weather. 77% of study participants of districts Peshawar and Mardan reported lack of input access as main risk source at their farm level, while in districts Charsadda and Nowshera the crop diseases and weather were reported at major risk sources at farm level as shown in Fig. 6.

Respondents perceived that floods, droughts and warmer summers were due to climate change and were among the serious threats to their farming.

Understanding farmers perceptions about undefined conditions are imperative for their decision (Huong et al., 2018a; Rasul et al., 2012). According to previous research by (Deressa et al., 2009) in Ethiopia, in adaptation process climate change is initial step. Several determinants make farm households vulnerable i.e. lack of inputs, access to timely farm resources including pesticides, labor and irrigation, Besides these, there also some other environmental determinants such as droughts and floods which increases farm households' vulnerability (Bukhari and Sayal, 2011; Rafiq and Blaschke, 2012). Several researchers have already focused on the effects of climate change on farm production

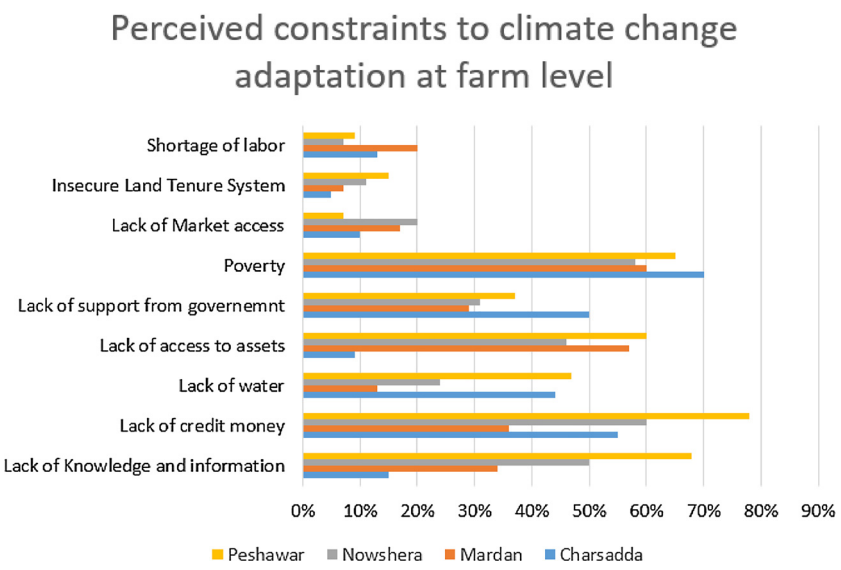
Perceived constraints to climate change adaptation at farm level
Shortage of labor
Insecure Land Tenure System
Lack of Market access
Poverty
Lack of support from governemnt
Lack of access to assets
Lack of water
Lack of credit money
Lack of Knowledge and information
0% 10% 20% 30% 40% 50% 60% 70% 80% 90%
Peshawar Nowshera Mardan Charsadda

Fig. 4. Perceived Constraints to Climate Change Adaptation at Farm Level.

Table 7
Perception on weather-related risks.
Source: Field Survey.

		Districts (Study Area)			
		Charsadda %	Mardan %	Nowshera %	Peshawar %
Temperature Change	No	41	49	84	44
	Yes	59	51	16	56
Excessive Rain	No	86	99	88	71
	Yes	14	1	12	29
Droughts	No	27	63	41	13
	Yes	73	37	59	87

Table 8
Perceived primary production risks.
Source: Field Survey.

		Districts (Study Area)			
		Charsadda %	Mardan %	Nowshera %	Peshawar %
Lack of access to inputs	No	67	23	71	23
	Yes	33	77	29	77
Diseases	No	56	73	82	64
	Yes	44	27	18	36
Weather	No	70	53	60	60
	Yes	30	47	40	40

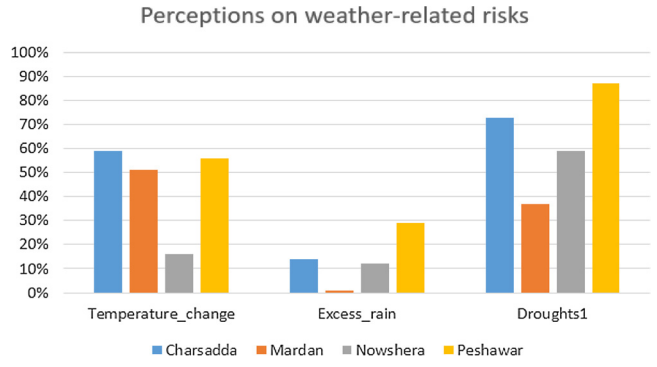

Fig. 5. Perception on Weather Related Risks.

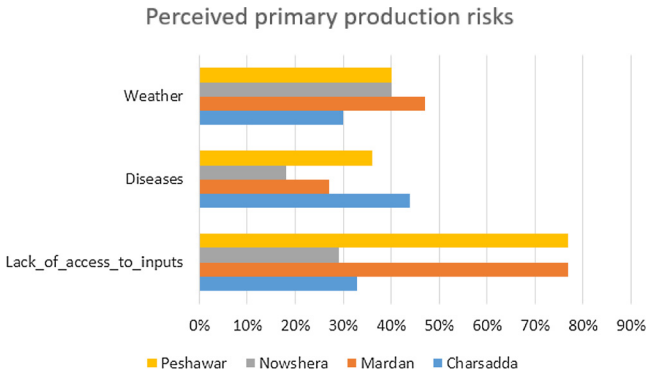

Fig. 6. Perceived Primary Production Risks.

around the globe (Hay and Mamura, 2010; Ali and Erenstein, 2016). Pakistan is an agricultural country and majority of the population are dependent on agriculture, but reduction in yield of main crops is common in Pakistan due to climatic risks (Tingju et al., 2014). Understanding the climatic risks and timely risk management strategies like crop insurance schemes are very essential to initiate, which will help farmers to cope with the climatic disasters (Fahad and Jing, 2018; Fahad et al., 2018b), that might be very helpful to identify the disadvantaged groups and make them sustainable (Adger and Kelly, 1999; Adger, 2003).

4. Conclusion

The present study focuses on the farm households' vulnerability and its related climatic risks due to variation in climate as well as their perception about risks associated with climate change and adaptation strategies and constraints espoused at farm level. Farm households perceived variation in climate might be a great threat to agriculture sector in future. The current study recognized variation in climate is adversely affecting farming sector especially rural farmers in Khyber Pakhtunkhwa province of Pakistan. Small subsistence farmers are the most disadvantaged group in farming sector, who are exposed to numerous climatic disasters. Farm households in the study area explained that droughts, floods maximum temperature, variation in precipitation are the major risks associated with climate change that have adversely affected the farming sector in the study area in recent years. Change in fertilizer, quality of seeds and changes in crop varieties were the main

adaption techniques adopted by study participants in the study area. Major constraints identified by farm households in the study area were lack of access to credit facilities, lack of access to extension services, lack of information or knowledge and lack of irrigation. It is very essential to make the farmers aware of these vulnerabilities related to climate change and provide them adequate facilities in order to adopt adaptation measures at their farm level. This study was only limited to four districts of Khyber Pakhtunkhwa province of Pakistan; therefore, this study endorses that such studies need to be conducted in other parts of the region which are more prone to climatic disasters. The concerned authorities at governmental level should implement certain policies in context to facilitate and encourage the farm households to adopt the advanced adaptation strategies in their farming activities.

Acknowledgements

Jianling Wang gratefully acknowledges the financial support from the Social Science Foundation of Ministry of Education of China Grant No. (16YJA630052) and Soft Science of Shaanxi Grant No. (2018KRM173).

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